Impact of Aerial Application of Malathion on Winnipeg Birds

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ABSTRACT

Cholinesterase (ChE) was determined in brains of house sparrows (Passer domesticus) and feral pigeons (Columba livia) collected both before and from 6 hours to 16 days after aerial application of malathion (210 ml/ha nominal rate). Caged sparrows exposed during the spraying at a site which received an actual dose of 140 ml/ha of malathion showed no change in behavior and suffered no mortality. Twelve hours after the exposure the mean brain ChE of sparrows was 6 percent lower than before the spraying, 12 percent lower in comparison to the levels measured in samples taken 15 and 16 days after the spraying. No change was observed in the brain ChE of pigeons. Although it was recognized that not all possible effects on all birds could be addressed on the basis of the study, it was concluded that there were no observable harmful effects on the tested species from either aerial or ground spraying, or the combination of both.

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INTRODUCTION

This bird monitoring project was undertaken as part of a multidisciplinary surveillance program in response to concern about non-target effects of aerial application of malathion over the City of Winnipeg (Manitoba) in July 1983. The spraying was ordered to control mosquitoes that are potential carriers of the Western Equine Encephalitis virus. Malathion was applied at a nominal rate of 210 ml/ha; the areas where the test birds were located was first covered on July 24, and re-sprayed again on August 14, 1983.

The toxic action of organophosphate insecticides (of which malathion is one) is attributed to their inhibition of cholinesterase (ChE) - an enzyme active in transmission of nerve impulses. Although the insecticides are much less toxic to vertebrates, many cases of bird mortalities from exposure to organophosphates have been recorded, and ChE inhibition was found in the poisoned birds (Rocco 1982, Hill and Fleming 1982). As the degree of inhibition is directly related to the pesticide dose, measurements of brain cholinesterase activity is a physiologically meaningful and reasonably simple way to assess the exposure of birds to ChE-inhibiting insecticides (Hill et al. 1971; Findlay et al. 1974; Busby et al. 1981, 1983).

In the present study house sparrows (Passer domesticus) and feral pigeons (Columba livia) were used as monitors of the spray effect, because of their abundance and wide distribution in the city, as well as their unprotected status. The objective was to assess the degree of ChE activity inhibition, rate of possible mortality, and the course of recovery of the ChE levels after the spraying.

MATERIALS AND METHODS

Sparrows were collected by mist netting in three Winnipeg backyards (West End and St. James area), pigeons were caught by hand nets in an old school building near the St. James Bridge.

In addition to the scheduled sampling, dead birds reported by the public were also picked up for testing. Members of the Rare Bird Alert group of the Manitoba Naturalists Society were asked to report any abnormal bird behavior or mortalities that they may observe following the spraying.

Twenty live sparrows were obtained prior to spraying and kept in a cage supplied with sunflower seed, bird seed mixture, and water ad lib. The cage was kept in an open shed outdoors for three days and in a closed garage for the last night before spraying, to protect it from ground fogging that was carried out in the area that night.

On the morning of the air spraying the caged birds were moved to an open area at Fort Whyte Nature Centre, where the spray distribution, droplet size, and application rate of the pesticide was monitored by the Environmental Protection Service (Environment Canada). The cage was left in situ during, and for three hours following the pass of the spray aircraft.

The sparrows from the cage were sacrificed at 6, 12, and 26-27 hours after exposure to the spray. Additional sparrows were collected one and two weeks later, from the same backyards. Pigeon collection took place 4 days before and 2, 9, and 15 days after the spraying. In total 41 sparrows and 39 pigeons were collected by

provincial personnel, and nine other birds and two squirrels were submitted by concerned citizens.

Excised brains were kept frozen in individual vials until analysis for ChE activity. All analyses were done by the Freshwater Institute, Canada Department of Fisheries and Oceans.

Brains were homogenized with a Polytron homogenizer and centrifuged at 21000 x g. to prepare a solution/suspension which was assayed by the colorimetric method of Ellman et al. (1961) using acetylthiocholine as substrate at 25°C. Results were expressed as milliunits of enzyme activity per mg of protein (mU/mg). Analytical precision of the method was about ± 15%.

RESULTS AND DISCUSSION

The caged sparrows did not show any ill effects or change in behavior during or after the spraying. The mean values of brain ChE activity of the sparrows are shown in Table 1. The post-spray specimens' ChE levels were slightly suppressed compared to the pre-spray and 15 to 16-day post-spray samples (about 6 and 12 percent, respectively). Although the nominal coverage was 210 ml/ha the actual spray deposition rate on the site where the cage was located was 140 ml/ha over the three hours of exposure (T. Youmans, Environment Canada, pers. communication).

There was no significant change in the ChE activity in any of the pigeon brain samples; there was less than 10 percent difference between sampling period means (Table 2).

Of the eleven samples collected by private citizens four were already decomposed, which prevented analysis and indicated that the deaths occurred before the aerial spraying. Analytical results for the other seven are given in Table 3. Pre-spray controls for these species were not collected, so that direct pre vs. post-spray comparison was not possible; however, the values were similar to those observed in the pigeon samples, a little lower than in the sparrow samples. Assuming that the ChE activity of the second Lipton St. purple martin was normal (cause of death was unknown), the ChE of the purple martin which died the first day after spraying would have been at a lethally low level. No reports of abnormal behavior or mortalities of birds were received from the Rare Bird Alert members.

According to Ludke et al. (1975), suppression of brain ChE activity (percentage inhibition) of 20 percent is indicative of exposure to pesticides, and 50 or more percent inhibition is sufficient for diagnosing death from anti-ChE poisoning. House sparrows which died from malathion poisoning in the experiments of Mehrotra et al. (1967; cited by Ludke et al. 1975) had brain ChE suppressed by about 80 percent (range 36 to near 100 percent). Winnipeg results did not approach even the lower range; they are similar to the findings of Hill et al. (1971). Hill and his co-workers found ChE of individual sparrows following an aerial application of malathion to be inhibited by 18 percent at the most . The rate of application was the same as during this study.

It is, unfortunately, not possible to assume without reservation that the pre-spray ChE activity values correspond to normal levels. The birds had been previously exposed to pesticides at various intervals as a result of ground fogging for mosquito control by the City of Winnipeg (Table 4). In addition, increasing mosquito numbers prompted the City to resume ground fogging on August 8. That, and a second round of aerial spraying (on August 14) in effect precluded continued sampling which was intended to assess the level at which the ChE activity would stabilize in the post-spray period.

The more or less constant level of ChE activity in pigeons might have been due to either their different habits (i.e. roosting inside the building), or the confounding effect of the ground fogging, or both.

The fact that no conspicuous bird mortality occurred in Winnipeg during or following the spraying indicates that the pesticide dose received by the birds from either ground or aerial spraying operations or their combination was not excessively high. This applies to both sparrows and pigeons, and probably may be extrapolated to other birds of similar size and habits.

There are several remaining questions, however, which a monitoring program set up on an emergency basis cannot answer, such as:

1) How are the insectivorous birds affected by the sudden disappearance of their food supply?
2) Are there more severe effects on nestlings, either from the pesticide or from the decreased food supply? (Even granivorous songbirds feed their young with insects).

3) What are the effects on the less visible bird species (e.g. the canopy-dwelling warblers), those which are less common, or those which may die in places not easily accessible where they would not be readily found?

4) Does exposure to the pesticide make the birds more vulnerable to predation?

Some of the questions could be answered by properly designed experiments, some it may not be practical for provincial agencies to address.

CONCLUSIONS

1) No large-scale bird mortality was either observed or reported in connection with the 1983 aerial application of malathion.

2) Exposure to the pesticide caused no observable ill effects in caged sparrows.

3) Although ground fogging by the City of Winnipeg added a confounding factor, it was observed that with one single exception none of the tested samples showed potentially harmful levels of brain ChE inhibition.

4) Some potential effects of spraying could not be evaluated on the basis of this monitoring program.

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TABLE 1: Brain ChE Activity in Sparrows

Sampling Time[1]	ChE Activity[2] mU/mg Mean (range)	n	ChE activity suppression, % compared to: pre-spray	15-16 day post-spray
Pre-spray (W)	134.5[a,b] (111-164)	10	0	6.7
Post-spray: 6 hours (C)	128.6[b] (117-137)	5	14.4	10.8
12 hours (C)	126.6[b] (101-148)	5	5.9	12.2
26-27 hours (C)	127.0[b] (113-143)	9	5.6	11.9
8 days (W)	130.2[b] (126-134)	6	3.4	9.7
15-16 Days (W)	144.2[a] (128-153)	6	-7.2	0

[1]W = birds from the wild; C = caged birds

[2]Means with different superscript are significantly different from each other ($p<0.05$, Duncan's New Multiple Range Test)

TABLE 2: Brain ChE activity in pigeons

Sampling Time	ChE Activity[1] mU/mg mean (range)	n
Pre-spray	102.5 (79-128)	9
Post-spray: 25-26 hrs.	107.0 (89-126)	10
9 days	105.3 (89-136)	10
15 days	111.0 (87-137)	10

[1] there is no significant difference between the means ($F = 0.501$, $p>0.1$)

TABLE 3: Brain ChE activity in samples submitted by citizens.

Location	Time of Collection	Species	Brain ChE Activity (mU/mg.)
Winnipeg			
209 Colony	1 day post-spraying	Red squirrel	103.3
11 Masterton	1 day post-spraying	Robin	106.0
St. Charles	1 day post-spraying	Red-wing blackbird	107.0
22 Lipton	1 day post-spraying	Purple martin nestling	48.7
22 Lipton	5 day post-spraying	Purple martin nestling	104.0
244 Hindley	1 day post-spraying	Grey squirrel	93.3
Brandon	unknown	Mourning dove	72.4

TABLE 4: Timetable of Events

Date	Bird collection	Pesticide application[1], early AM, or previous night	
		Sparrow collection site	Pigeon collection site
July 14			Propoxur (Baygon)
17		methoxychlor	
19	pigeons		
20	sparrows		
21	sparrows		
23		malathion	
24	caged sparrows	Aerial spraying of malathion	
25	caged sparrows; pigeons		
Aug 1	sparrows		
2	pigeons		
8	sparrows; pigeons		malathion
9	sparrows	malathion	
14		Aerial spraying of malathion	

[1] Ground fogging unless otherwise stated. Baygon and malathion are ChE inhibitors, methoxychlor is not.